

What Is Claimed Is:

1. A finger print minutiae extraction method comprising:
  2. acquiring fingerprint image data;
  3. partitioning said fingerprint image data into at least one data block corresponding to a local area of said image data;
  5. generating a histogram function of a contrast level of said image data corresponding to said data blocks; and
  7. performing a histogram transformation of said histogram function, wherein said histogram transformation is adapted to the contrast level of said local area of said fingerprint image data and pre-enhanced fingerprint image data is generated with local enhancement.
2. The method of claim 1, further comprising:
  3. partitioning said fingerprint image data into a plurality of data blocks, each of said plurality of blocks corresponding to a different local area of said image data and at least one of said plurality blocks having a contrast level different than a second of said plurality of data blocks,
  5. wherein said histogram transformation is adapted to said different contrast levels of said plurality of blocks and pre-enhanced fingerprint image data is generated with local enhancement for a plurality of local areas of said image data.
3. The method of claim 1, wherein said histogram transformation includes using an objective function with a relatively high value at both endpoints of an intensity interval and a relatively low value at a middle of said intensity interval.
4. The method of claim 1, wherein noise and distortions in said image data are reduced.

1        5. The method of claim 1, wherein said histogram transform maps said  
2 histogram function to a specific function according to a mapping algorithm including

3        
$$x \mapsto \arg \min_y \{y \mid \int_0^y g(t) dt < f(y)\}$$

4        wherein  $f(x)$  is a target histogram function and said target histogram function has  
5 low value at the mid-point and has a high value at the endpoint of the interval.

1        6. The method of claim 1, further comprising:

2              performing orientation filtering on said pre-enhanced data using  
3 directional convolution for two dimensional digital image processing,

4              wherein said pre-enhanced image data is smoothed and enhanced.

5        7. The method of claim 6, wherein the following algorithm is used in said  
orientation filtering

$$g(i, j, k) = \sum_{l=1}^M f(i + y_{\text{offset}}(l), j + x_{\text{offset}}(l)) \times h(l).$$

1        8. The method of claim 1, further comprising:

2              thinning said fingerprint image data to remove false connections of ridges  
in said data,

3              wherein said thinning includes applying a first table and a second table to  
5 a plurality of pixels using an algorithm.

1        9. The method of claim 1, further comprising generating a first table and a second  
2 table using rules for character data and biological data.

1        10. The method of claim 9, wherein said rules for biological data include

2              If  $P_1 * P_7 * P_8 = 1$  and  $P_2 + P_6 > 0$  and  $P_3 + P_5 = 0$  then  $\text{LUT}_1(P) = 0$ ;

3              If  $P_5 * P_6 * P_7 = 1$  and  $P_4 + P_8 > 0$  and  $P_1 + P_3 = 0$  then  $\text{LUT}_1(P) = 0$ ;

4              If  $P_1 * P_2 * P_3 = 1$  and  $P_4 + P_8 > 0$  and  $P_5 + P_7 = 0$  then  $\text{LUT}_2(P) = 0$ ; and

5              If  $P_3 * P_4 * P_5 = 1$  and  $P_2 + P_6 > 0$  and  $P_1 + P_7 = 0$  then  $\text{LUT}_2(P) = 0$ ,

6       wherein A(P) is a number of 0-1 patterns in an order set P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>, P<sub>4</sub>, P<sub>5</sub>, P<sub>6</sub>,  
7   P<sub>7</sub>, P<sub>8</sub>, P<sub>1</sub>, where P<sub>i</sub>, i=1,...,8, are 8-neighbors of a pixel in a clockwise direction, and  
8   B(P) is a number of nonzero neighbors of P.

1       11. A method for fingerprint registration and verification from minutiae comprising:  
2              performing a Hough transform on fingerprint image data and generating  
3              evidences in lattice bins;  
4              counting the evidences accumulated in said lattice bin;  
5              shifting a lattice;  
6              determining the number of evidences in each bin of said shifted lattice;  
7              repeating said shifting and counting in each direction of said lattice until a  
8              bin is completely overlapped with its diagonal neighbor,  
9              wherein shifting the lattice enhances the spatial resolution of the Hough  
10             transform.

1       12. The method of claim 10, wherein said shifting said lattice occurs at a  
2             predetermined step size.

1       13. The method of claim 10, wherein said shifting the lattice partitions each  
2             bin into blocks, each block is assigned a number equal to the number of evidences  
3             in the corresponding bin, the numbers of the overlapped blocks are summed and  
4             transform parameters are specified using the block that corresponds to the highest  
5             sum.

1       14. The method of claim 10, further comprising:  
2              determining the maximum number of evidence counts in the bins;  
3              determining transformation parameters corresponding to the bins with the  
4              maximum evidence counts;  
5              determining the variance of said transformational parameters;  
6              determining a matching score of a fingerprint image and a template  
7              fingerprint image based on said variance of the transformational parameters and said  
8              maximum number of counts.

1       15. The method of claim 13, wherein the matching score is determined using a  
2       sigmoid nonlinear function.

1       16. A system for biological data matching comprising:  
2               an image reader for acquiring personal biological image data;  
3               a template of biological image data;  
4               a pre-enhancing unit adapted to pre-enhance said personal biological  
5       image data according to local and global areas of contrast;  
6               an image smoothing and enhancement filter for enhancing said pre-  
7       enhanced image data;  
8               an orientation data thinner for removing false data in said personal  
9       biological image data;  
10          a registration unit for aligning said personal biological image data with  
11       said template image data; and  
12          a matching score generating unit for determining if said biological data  
13       matches said template print.

1       17. The system of claim 15, wherein said personal biological image data and  
2       said temple image data include a fingerprint, iris, voice, hand geometry, face, or palm  
3       pattern.

1        18. The system of claim 15, further comprising:  
2            a database including a plurality of templates of biological image data,  
3            wherein said system determines which template of said plurality of  
4 templates in said database matches said personal biological image data.

1        19. The system of claim 15, wherein said registration unit aligns said image  
2            data with said template using a Hough transform and shifts a lattice to enhance the  
3            spatial resolution of the Hough transform.

1        20. The system of claim 15, wherein said pre-enhancing unit enhances local  
2            areas of contrast by partitioning said image data into image data blocks, generating  
3            a histogram function of a contrast level of said image data corresponding to said  
4 data blocks, and performing a histogram transformation of said histogram function.

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